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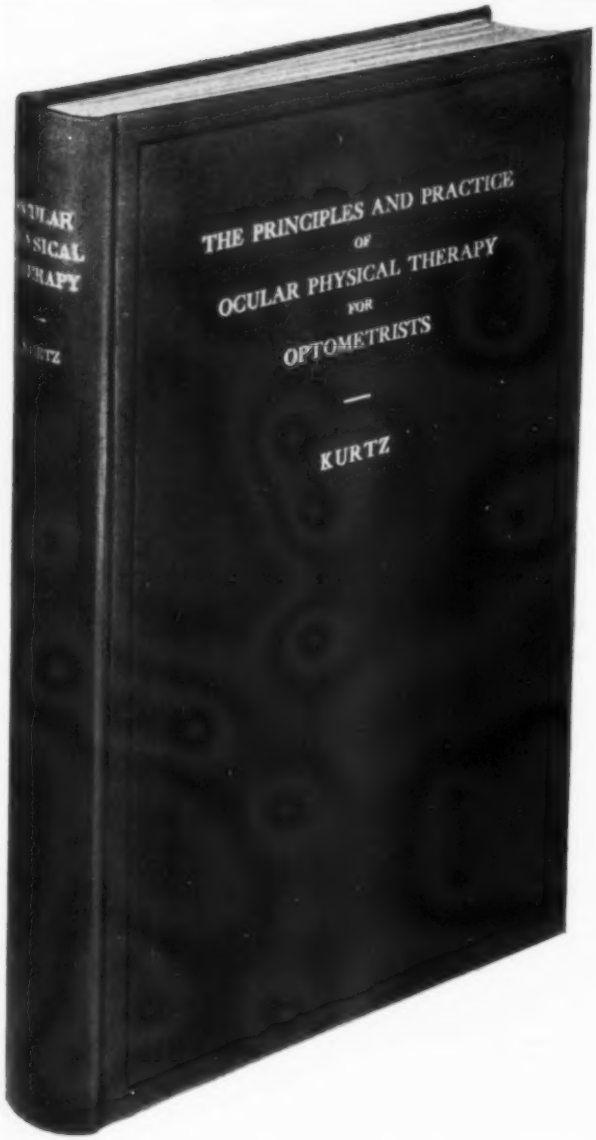

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AMERICAN JOURNAL OF OPTOMETRY

Vol. 14 JULY, 1937 No. 7

CONTENTS

ORIGINAL PAPERS

A New Absorption Lens for Use in Selected Cases of Senile Cataract with Negative Histories. E. LeRoy Ryer and Elmer E. Hotaling 244

A Plea for Better Thinking and a Sounder Background of Physiological Knowledge for Our Orthoptic Procedures. Norman A. Zevin 261

Report on Three Cases of Progressive Myopia and One Case of Hyperphoria. Eric Bateman 269

EDITORIALS

The General and Ocular Fatigue Problem. J. I. Kurtz 273

SPECIAL REPORTS

On Presenting Optometric Fees. Harris Gruman 280

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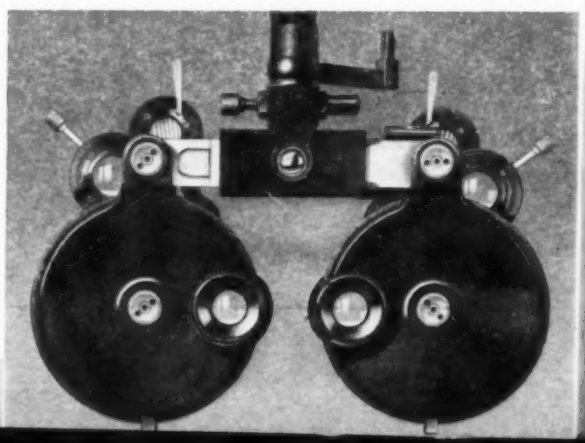

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AMERICAN JOURNAL OF OPTOMETRY

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A NEW ABSORPTION LENS FOR USE IN SELECTED CASES OF SENILE CATARACT WITH NEGATIVE HISTORIES*

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As far back as history goes, we find attention attracted to opacities behind the pupillary area. Egyptians, Greeks, Chinese, Jews, Arabians, of old, as well as all those who have come after them, have expressed opinions on etiology, treatment, and prognosis of cataract.

Thus far the chief value of these opinions seems to be in showing how slowly scientific knowledge may be coordinated and assimilated and how stubbornly traditional beliefs may impede true progress.

Still, in all ages, among all peoples, commendable efforts have been made to combat this all-to-prevalent affliction.

Judged in the light of prevention, the results of these efforts have been meagre. True, cataract operative technique has been improved in many details but definite means of retarding cataract have been sought in vain, and true preventive methods barely considered.

From time to time so-called preventive measures have been advanced which promised relief. Some cases they did relieve, yet not one of these measures achieved the end of universal appliability and universal helpfulness.

This lack of success should serve to moderate the undue enthusiasm which usually accompanies each promising advance. It should not, however, be permitted to discourage aggressive research. And though so far no curative or palliative method applicable to all forms of cataract has been found, advantage should be taken of any method which helps any one form to however limited an extent. The etiological factors are obviously so variable that to look for a universally applicable remedy is fatuous. So far as palliative methods go, the most that can be looked for rationally is a number of palliatives applicable to a number of forms of cataract.

*An abridgment of the material presented before the American Academy of Optometry August 24, 1936.

Careful reading of the literature will convince anyone that the terms "prevention" and "retardation" have been confused, confounded, and misapplied throughout. The term "prevention" in nearly every instance has been employed to signify not true prevention but prevention, that is, retardation of, an already existent cataract. The term "prevention" has been used generally in the sense of preventing an incipient cataract from reaching maturity. Incipient cataract or definite symptoms of cataract had to show themselves before preventive measures were considered.

No invidious comparison of other methods with ours is intended. We ourselves until recently, applied the term "prevention" in the accepted way. When, in 1929, we published the results of use of a heat-absorbing glass, we based our statistics solely on cases of pre-existing cataracts.

We assumed, traditionally, that some persons were more susceptible to cataract than others and that heredity was an important factor.

On that basis, the moment we discovered the slightest sign of cataract we instituted what we called a "preventive" method but what was actually only a *repressive* method, and had we differentiated sooner, we would have sought sooner the true preventive method which we found later and which consisted merely of applying the same means as long as possible *before* instead of as soon as possible *after* the discovery of opacification of the lens.

The results, as many of you proved for yourselves subsequently, were so gratifying as to lull us into a state of complacency—never a safe state, by the way—until a little further study (or rather, a little common sense coordination of facts already well known and well established) opened the way toward true prevention. We had brought into the open, however, one of the major causes of cataract as well as a reasonably effective palliative. Both the cause and the heat-absorbing glass had been noted in the past but neither the full significance of the first nor the potential effectiveness of the second seemed to have received due recognition or fair evaluation.

To those who have had good results from the use of heat absorbing glass in the retardation of incipient cataract, this further step we suggest will not seem radical. Neither will the new form of lens we offer, or its wider scope of application, seem more than natural developments.

Mention was made above of coordinating some well-established knowledge. The object of this paper is to select typical examples from various classes of well known facts in order to demonstrate that our method of preventing cataract—preventing in the true sense—by eliminating a potent cause long before it effects the lens deleteriously, is soundly based.

Keep in mind we make no pretense of order or of thoroughness but of a broad outline which leads irresistibly to the conclusion that infra-red radiation may cause coagulation, hence opacification in the lens,

hence cataract; that the absorption of this potentially dangerous radiation has proved effective in retarding already existent cataract; and, therefore, that this absorptive method cannot be applied too early but rather as long as possible *before* any effect is evidenced in the eye.

The points which follow, disjointed as they may seem, coordinate themselves:

HEREDITY—AN ALL-OR-NONE ISSUE

(1) We dismiss heredity, per se, as a factor of any practical usefulness in the treatment of this problem, believing that everyone inherits the tendency to cataract as surely as he inherits the tendency to old age.

Throughout the literature writers, consciously or unconsciously, but nonetheless regularly, show that they suspect this. None, however, permits himself to arrive at that logical conclusion.

In spite of the many references in many text-books to the possible heredity of cataract and of the studies of Rampoldi,[1] Fromaget,[2], Daust,[3] and especially of Nettleship,[4], and Stricker,[5] whose studies are most complete, there is really very little substantiating evidence. Such evidence as has been offered is that of an odd single family here and there, evidence which is offered in favor of the heredity theory, but is really evidence against it.

For example, Posey[6] says, "Cataracts may occur at any age but are generally observed in infancy or old age. Infants may be born blind in consequence of them and extreme longevity is nearly always associated with more or less haze of the lens. Cataracts are often hereditary, particularly the congenital type. Transmission, as a rule, is direct, the skipping of a generation being unusual."

Let us analyze that. If, as he states, cataracts occur generally in infancy and old age, then they do not occur in middle life, as we all know; and as only a relatively few occur in infancy, most of them occur in old age. He reiterates that infants may be born blind due to cataracts. All right, how many are so born? Obviously, very few. But, he says, nearly all really old lenses are hazy. This we know to be true. He adds, the congenital type are particularly hereditary. We ask, how many congenital cases are there and why labor the distinction between congenital cases and infants born blind? He speaks of one generation not being skipped, apparently missing the point that in true hereditary transmission one generation usually *is* skipped.

Greene[7] states: "When one considers that changes in the lens affecting its transparency are rather the rule than the exception in persons above the age of 60, deductions as to the *heredity* of *senile cataract*, at least, should be drawn with considerable reserve. Every now and then, however, one encounters familiar cataract presenting characteristics, either in itself or in individuals affected by it, that point irresistably to a true hereditary influence."

Norris[13] notes that the more one examines the eyes of elderly people the more one is struck with the extreme frequency with which some degree of opacity of the lens is found—so much so that one is almost inclined to agree with the famous dictum of Walther, that every one becomes cataractous who does not die prematurely. He adds that out of 1545 patients 50 years of age 449 had some opacity. Arranged in five-year periods the percentages showing opacities were as follows:

15 per cent between 50 and 55

16.1 per cent between 55 and 60

30.2 per cent between 60 and 65

while in the ten year period between 65 and 75, 77 per cent had cataract.

Now and then we do find a case that appears to be one of heredity but only now and then, and even this is probably the result of some truly inherited disease of which the cataract is merely a symptom.

We quote these examples as the usual attempts made to prove heredity a factor by naively showing it is not.

Aside, then, from a relatively small number of juvenile, secondary and traumatic cases of cataract, it is safe to assume that most people will not develop cataract until past middle life; that anyone may develop it after middle life but that the time of onset may be pushed back by starting as early as possible to offset the effects of exposure to light, to strong light especially, by wearing heat-absorbing glasses as much as is feasible.

CATARACT ON THE INCREASE

(2) Some are prone to assume that because of the marked improvement in the technique of cataract extraction, cataract itself is being properly combatted. This is looking at the problem from the wrong end. The most successful operation conceivable helps not one whit in preventing cataract, nor does successful operative treatment in one eye of an individual help prevent its development in the other eye.

The real problem is to reduce the chances of cataract by eliminating the cause or causes of cataract before they have affected the lens.

Specifically we wish to eliminate one potent cause of cataract which under modern living conditions is becoming a rapidly increasing menace.

There seems little reason to doubt that excessive exposure of the crystalline lens to infra-red radiation is a causative factor in cataract. Does modern life expose the lens unduly to this harmful radiation? We think it does. Hats are worn less. The eyeballs are more prominent. Longer hours are spent under artificial illumination. Artificial illumination (richer, incidentally, in infra-red waves) is of higher intensities, and going still higher. There is far more general participation in winter and summer sports on land, on water, and in the air; skiing, tobogganing, skating, snowshoeing, tennis, golf, polo, motoring, fishing, swimming, bathing, boating, aquaplaning, and flying.

The point need not be labored further. Ask yourself whether or not you expose your eyes to the glare from water, snow, ice, cement roadway and sky? Whether or not your eyes beg for protection from the effects of this bright light? Whether or not those whom you see and know expose their eyes more and more to bright light?

There is no question that tinted glasses will be worn more and more to avoid the resultant discomfort. In selecting the glass that eliminates the glare, we urge the use of a glass which at the same time absorbs and eliminates the infra-red radiation which is so apt to hurry the changes in the crystalline lens that lead to cataract.

If infra-red radiation is potentially dangerous, the earlier it is eliminated the better because, as we will show in detail later, one little spot of coagulated protein formed in the lens by excessive exposure to the infra-red radiation of natural or artificial light becomes in itself immediately a serious source of danger insofar as it absorbs instead of transmits the light that strikes it and becomes a hot spot bound to affect surrounding tissues deleteriously.

Sex

(3) The sex question often arises in relation to cataract and Nettleship[4] answers it by showing

(a) that family cataract more often descends through the female members, and (b) that heredity cataract tends to select one sex to the exclusion of the other.

In view of what has been said about heredity, as well as what is seen in regular practice, it may be concluded safely that cataract is no respecter of persons nor of sex.

PROTEIN AND ALBUMIN CONTENT OF THE CRYSTALLINE LENS

Huxley as far back as 1870 pointed out a most significant fact that should have been applied earlier to this problem: "All the forms of protoplasm which have yet been examined contain the four elements, carbon, hydrogen, oxygen, and nitrogen, in very complex union and behaving similarly towards several reagents. To this complex combination the name of Protein has been applied. And if we use this term with such caution as may properly arise out of our comparative ignorance of the things for which it stands, it may be truly said, that all protoplasm is proteinaceous, or, as the white, or albumin, of an egg is one of the commonest examples of a nearly pure protein matter, we may say that all living matter is more or less albuminoid.

Perhaps it would not yet be safe to say that all forms of protoplasm are affected by the direct action of electric shocks; and yet the number of cases in which the contraction of protoplasm is shown to be affected by this agency increases every day.

Nor can it be affirmed with perfect confidence, that all forms of protoplasm are liable to undergo that peculiar coagulation at a temperature of 40 to 50 degrees centigrade (129.6—147.6 degrees Fahrenheit),

which has been called "heat stiffening," though Kuhne's beautiful researches have proved this occurrence to take place in so many and such diverse living beings, that it is hardly rash to expect that the law holds good for all.

Incidentally, Stricker[5] quotes Kuhne[9] and Knies,[10] the former as having found that the crystalline lens contains water 60 per cent, albuminous material 37.5 per cent, fat and cholesterine 2 per cent, and ashes 0.5 per cent and the latter as claiming that the substance of the nucleus of cataract is albuminous in nature.

Zoethout[11] points out that the composition of the lens is characterized by its low water content, 63%, which is even a little less than that of bones, and a high per cent of proteins, 35%, which is higher than that of any other structure.

Adler[12] agrees that the lens contains a higher percentage of protein than any other organ in the body, the total proteins making up about 35% of the lens mass.

PROTEIN FACTOR IN CATARACT

Coagulation of the protein of the crystalline lens fibers brings about the formation of opacities, and coagulation of proteins may result from all forms of radiant energy as well as from mechanical stress. Hence, as Adler[12] points out, it is easy to visualize how these factors might apply to cataract formation since the lens is constantly exposed to light and may easily be traumatized. Just as egg white is a protein which becomes opaque on coagulation, so the lens fibers lose their transparency when they become coagulated. Heat is a potent coagulant.

HEAT IS A CAUSE OF CATARACT

Norris[13] affords an excellent review of the work done to demonstrate the effect of heat and cold on the transparency of the crystalline lens. He points out that Wernek showed that concentration of the sun's rays by a burning glass caused the lens to split in the direction of its meredians and to become opaque; that Beer, Walther, Mackenzie, Arlt, and Hasner, from their clinical experience, all adduce radiant heat as a predisposing cause of lenticular opacity; that Hirschberg reports five out of thirty glass-blowers in one factory have cataract and holds that when one is long exposed to high heat, so much is absorbed by the lens as to cause fine internal changes and subsequent loss of transparency.

Norris[13] himself is convinced from his examinations of a number of men who were exposed constantly to intense radiant heat—puddlers, stokers, glass-blowers, etc.—that such exposure results in a disturbance of the nutrition and resultant greater or less opacification of the lens.

Hirschberg reports many more ripe cataracts in the farming class at 50 years of age than in city dwellers of the same age and attributes this to the exposure of the former to more intense light, glare and heat. In countries where the climate is hot, like the West Indies, the majority of

cataract patients come to operation at about forty while in Europe the majority of extractions are at sixty-two years of age.

A very significant report of VonAmmon is that of cases who were burned to death in a railway accident whose eyes showed the sclerotic and cornea wrinkled, the retina detached, the vitreous shrunken, resembling coagulated albumin, the lens capsule white and thickened, and the lens substance itself white, opaque, and adhered to the capsule.

ONLY ABSORBED LIGHT ACTIVATES

The most basic physical fact, the one fact the significance of which must never be forgotten, is that light which passes through a substance never affects that substance. Put another way, and we cannot be too explicit on this point, only when light is absorbed by a substance does it affect or act upon that substance. The law that light must be absorbed in order to produce an effect was first clearly enunciated by Grotthus, 1819, and independently, at a later date, 1841 by Draper. It is frequently known as Draper's Law.

Let, then, a single piece of protein in the lens be coagulated by any means and it at once absorbs light, increases in temperature and begins to affect surrounding tissue deleteriously.

LOSS OF OPTICAL CONTINUITY MEANS LOSS OF TRANSPARENCY

Wherever optical continuity is ruptured we have multiple reflection of the incident light. A piece of homogeneous glass with polished surfaces is highly transparent, permitting most light that enters it to pass through. That same piece of glass if pulverized becomes totally opaque, i.e., permits no light to pass through it because of the multitude of reflections at the limiting surfaces of the particles.

If the lens tissue breaks down from any cause we duplicate the above condition to the extent of the breakdown and by multiple reflections keep that much more light and consequently that much more heat in the lens. And the richer the light is in relatively hot infra-red radiations the greater the menace or, conversely, the more infra-red that can be filtered out the less the danger. Hence the value of an infra-red absorptive glass.

LIGHT TURNED TO HEAT

In round numbers, when light of the longest visible wave-length passes through an eye, 400,000,000,000,000 of these waves reach the retina every second. The retina normally transforms this energy into the sensation we call red.

Light of the shortest visible wave-length, if not retarded, reaches the retina at the rate of 800,000,000,000,000 every second.

If, however, the cornea, aqueous, crystalline lens, or vitreous retards or absorbs any of these waves, this energy is transformed into heat.

CHEMICAL ACTION OF LIGHT

Beyond the extreme violet of the spectrum is a vast series of waves which are incapable of awakening the optic nerve but capable of shaking asunder the molecules of certain compound substances on which they impinge and thus produce chemical decomposition.

Incidentally, the glass that cuts off 95% of the infra-red waves, cuts off 100% or all of these ultra-violet waves.

FLUORESCENCE

As a rule we think of bodies either transmitting light or absorbing it. There is a third case in which the light falling upon certain substances is neither transmitted nor absorbed but converted into light of another kind. For example, when invisible ultra-violet waves impinge upon sulphate of quinine they cause its molecules to vibrate and, peculiarly, the vibrations thus set up are of slower period than those of the exciting waves and come within the range of vision. This rendering visible of the invisible ultra-violet waves is called fluorescence. It strikes us as significant that the human crystalline lens fluoresces in total darkness under the influence of invisible ultra-violet waves.

CALORESCENCE

Infra-red invisible waves may be concentrated upon a platinum wire and raised to visibility. This is called calorescence.

With suitable precaution the eye has been placed in a focus competent to heat platinum to vivid redness without experiencing the slightest sensation of either light or heat. But let any particle in that eye hinder or absorb these waves and heat would immediately result.

It is with such a thought in mind that we urge using any means possible to prevent the slightest opacity forming in an eye, not waiting until some opacity is discernible and then trying to prevent its enlargement but recognizing the grave danger of the slightest opacity as a potential heat source and starting as early as possible to prevent *that*.

HEAT FROM ICE

Light reflected from or transmitted through snow or ice might be considered incapable of producing heat but a lens moulded from ice will act just as effectively as a burning-glass and used thus as a condenser will burn black paper or melt a metal such as zinc. In arctic expeditions gunpowder has been exploded by the sun's rays converged by large lenses of ice.

Infra-red waves reflected from snow lose none of their heat because the snow is cold. The waves thus reflected neither affect or are affected by the snow. It is such simple facts as these that the optometrist must make clear to his patients before they can be expected to appreciate the value of true cataract prevention.

The substantial identity of light and radiant heat has been established beyond doubt by many forms of trustworthy experiments, but it

is not sufficient that scientists know this. The laity, too, must comprehend it if preventive methods are to be applied in time to do the most good.

IMPORTANT KNOWLEDGE SHELVED

The second most important physical fact in any consideration of heat in relation to cataract formation is one that has been almost ignored in the literature. Here is an excellent example of important knowledge being shelved inadvertently for years.

In 1873 Tyndall,[14] in one of the six lectures he delivered in the United States, made the following remarks and experiment:

"We have finally to determine the position and magnitude of the invisible radiation. For this purpose we employ a particular form of thermo-pile. Its face is a rectangle, which by movable side-pieces can be rendered as narrow as desirable. Throwing a small and concentrated spectrum upon a screen, by means of an endless screw we move the rectangular pile through the entire spectrum, and determine in succession the thermal power of all its colors.

"When this instrument is brought to the violet end of the spectrum, the heat is found to be almost insensible. As the pile gradually moves from the violet towards the red, it encounters a gradually augmenting heat. The red itself possesses the highest heating power of all the colors of the spectrum. Pushing the pile into the dark space beyond the red, the heat rises suddenly in intensity, and at some distance beyond the red it attains a maximum. From this point the heat falls somewhat more rapidly than it arose, and afterwards gradually fades away. The accompanying curve represents the distribution of heat in our spectrum. Beginning at the blue, the curve rises, at first very gradually; towards the red it rises more rapidly; the line C D representing the strength of the extreme visible red radiation. Beyond the red it shoots upwards in a steep and massive peak to B; whence it falls, rapidly for a time, and afterwards gradually fades from the perception of the pile.

"So it safely may be concluded that the areas of the dark and white spaces, respectively, represent the relative energies of the visible and invisible radiation. The one is 7.7 times the other.

"But in verification consists the strength of science. Determining in the first place the total emission from the electric lamp; then by means of the iodine filter determining the infra-red emission; the difference between both gives the lumionus emission. In this way, it is found that the energy of the invisible emission is eight times that of the visible.

"No two methods could be more opposed to each other, and hardly any two results could better harmonize. I think, therefore, you may rely upon the accuracy of the distribution of the heat here assigned to the prismatic spectrum of the electric light. There is nothing vague in this mode of investigation, or doubtful in its conclusion."

How can one look at this curve, note the extreme heat of the invisible infra-red radiation just beyond the visible red, recall the coagulating effect heat has upon protein and the percentage of protein in the crystalline lens, and fail to appreciate the value of a glass that will permit much of the visible light to pass while cutting off more than 95% of the hot invisible infra-red radiation?

THE SCHERER CATARACT SPECTACLE

In nuclear cataract Scherer[15] obtained excellent results in reading glasses by using an opaque shield that covered the lens except for a ten millimeter circular opening through which the patient read. He improved this by adding a side shield which excluded light that ordinarily gets into the eye without passing through the lens. The underlying principle embodied a dilatation of the pupil beyond the edge of the central opacity but had nothing to do directly with the absorption of radiation of any specific wave-length.

The spectacle, obviously, was of no use for distance vision wear because of the limited field.

THE ORIGINAL RYER-HOTALING CATARACT SPECTACLE

Improving upon the Scherer opaque shield, Ryer and Hotaling[16] made a lens which left a horseshoe shaped uncolored reading area in the lower central part of an amber colored lens. This was obtained by a special electrical process known as neutraliting. The amber area absorbed sufficient light to cause dilatation of the pupil yet permitted full freedom of distance vision.

But the full value of heat absorbing lens still went unappreciated.

THE NEW RYER-HOTALING CATARACT PREVENTION LENS

Each year since 1929, at which time we presented to the American Academy of Optometry the results of our initial investigations, we have reported an ever-increasing number of cases of cataract which have been benefitted by the infra-red-free or heat-absorbing lens we offered at that time.

Thus there exists more than sufficient evidence to establish the fact that the human crystalline lens contains substances which if exposed under certain conditions to excessive radiant energy lose their transparency and become opaque.

From a practical standpoint it makes little difference what these substances are or how heat acts upon them to change their transparency to translucency and opaqueness because any opacity of the crystalline lens is classified as cataract.

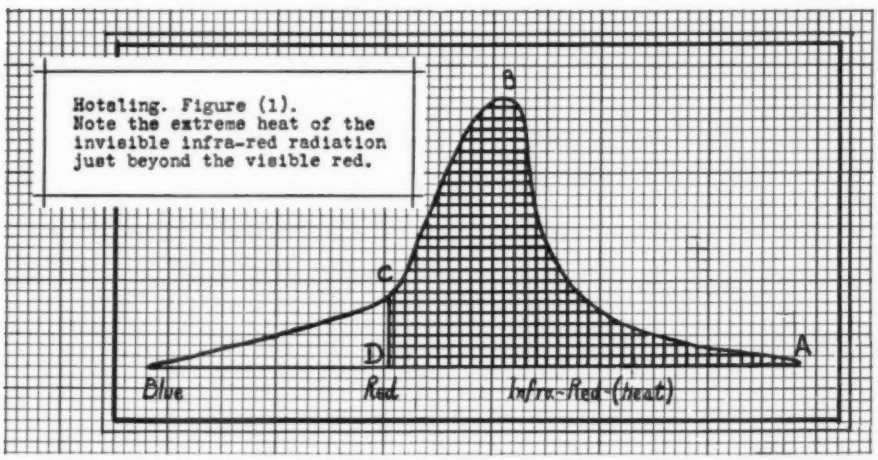
Keeping a few basic principles in mind it is not difficult to conceive heat causing cataract.

If light passes through a substance without any hinderance whatever it does not affect that substance. It is only when that light or some part of it is absorbed that it acts and when light is absorbed or "resisted"

it is transformed into heat. If an egg be baked, its albumin changes from a clear transparent to an opaque-white substance.

There is albumin, among other substances, in the human crystalline lens. Let the tiniest spot of albumin become opaque and it immediately becomes a danger spot because it will absorb more light, transform it into heat, become a source of heat itself and effect deleteriously other tissue in its vicinity.

Starting at the violet of the visible spectrum the calorific quality of the light rises regularly through, blue, green, yellow, orange, and red. This is known very generally. But it is not so generally known that as we pass beyond the visible into the invisible infra-red region the heat rises suddenly and enormously in intensity. Relatively the visible light rays are a mere insignificant appendage to the invisible heat rays. (See Figure 1.)



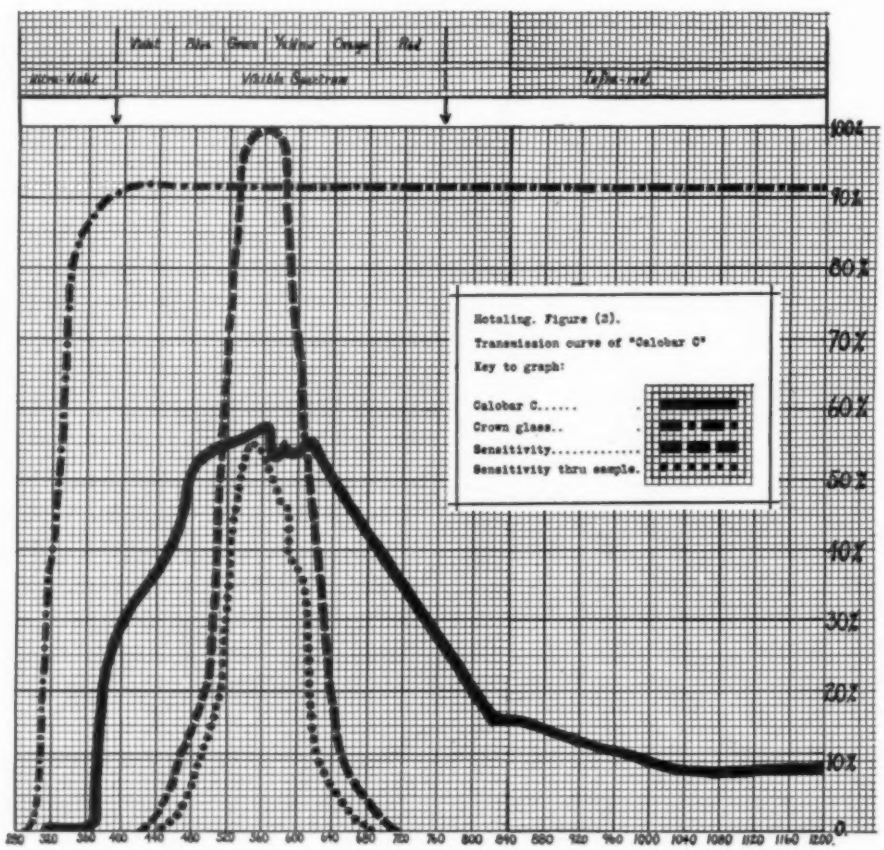
If, then, there be albumin and other substances in the human crystalline lens which become opaque if exposed to heat rays, it follows that cataract in its incipiency may be avoided or retarded by protecting the lens against heat rays and especially against those intensely hot invisible infra-red rays lying just beyond the visible red.

The glass whose use we urged in 1929, and which we have used and which no doubt many of you have used with gratifying results, prevents a large part of the infra-red rays from entering the eye. This glass absorbs these rays and would get very hot were it not for the air on each side of it insuring rapid radiation but the heat created here is nothing like as dangerous as if it were created by similar absorption in the cornea, the aqueous, the iris, or the crystalline lens, of the eye itself.

As a warning we cite an experiment that might have had disastrous results. We passed an intense beam of light through two layers of glass to measure the absorption. One layer was opal-white, the other heat-absorptive green. The white was nearer the light source but did not shatter. The green, however, became so hot so suddenly that it shattered with enormous explosive force and might have caused serious damage had it not been contained within a brass frame which kept the parts from flying about.

The glass used is known as Calobar and the transmission curve of its C shade is shown in Figure 2.

It will be noted that this glass affords full protection against ultra-violet radiations and ample absorption of infra-red radiations. The luminosity reduction of 45 per cent has no detrimental effect upon visual acuity under medium and high illuminations, in fact, sharpens vision outdoors when the light is bright.



This heat absorption glass is of high quality and is most satisfactory. No fault is to be found with it *per se*, and the modification we now offer is no more than a refinement introduced to equalize quantitatively, not qualitatively, the absorption in all parts of high power convex and concave lenses, so often used in these cases. In low and medium powers of both convex and concave lenses, differences in degree of coloring between their thin and thick portions is not objectionable but in high power lenses there does arise some objection which calls for elimination and which we have eliminated by a new form of lens.

In a high-power convex lens made of infra-red absorptive or so called red-free glass, the middle is a very dark shade while the edge is relatively a very light tint. This is more objectionable than may appear at first thought.

So far as comfort is concerned the patient merely by moving the head a little may bring any degree of shade, from the lightest of the edge to the darkest of the middle, between his fovea and any offending light source. But while this glass does afford real comfort its primary function as we are considering it is not to afford comfort nor even to prevent the infra-red rays striking the fovea but to prevent those hot infra-red rays entering the eye at any angle whatsoever. It may be the rays which follow the principal axis back to the macula that cause conscious discomfort but infra-red rays which might pass through the cornea at the greatest obliquity possible and still reach the iris or pass through the pupil into the very edge of the crystalline lens may damage susceptible substances within the crystalline just as much as direct rays might do and without giving the warning sensation of glare.

Furthermore, with the middle of the lens dark and the edge light (and such lenses are ground to the thinnest edge possible to avoid extra weight and thickness) the patient who naturally looks through the middle area is looking through the darkest area most of the time which tends to cause undue dilatation of the pupil in meeting the requirements of this darkened area and thereby exposing that much more of the crystalline lens to the infra-red radiation coming through the periphery of the glass lens.

In some cases such a lens may prove particularly objectionable for night motor driving because the eye, looking straight ahead, has to pierce the darkest area of the lens while the blinding glare from the headlights of passing cars reaches the eye through the lightly shaded peripheral area of the lens.

Incidentally the concave lens of this type affords the ideal lens for such driving because of its lightly shaded middle and darkly shaded peripheral areas.

In a high power concave lens made of red-free glass, the middle being almost white and the peripheral areas relatively very heavily shaded, the uneven shading is less objectionable in many ways than in an equally high power convex lens, is, in fact, sometimes a positive ad-

vantage. For example, it protects the crystalline lens against the hot infra-red rays from essentially all directions except along the line of the principal axis, that is, through its middle or lightly shaded area, and excessive light along this line will strike the macula and thereby cause sufficient discomfort to attract attention and demand relief.

Ground for objection to these unevenly shaded lenses, whether convex or concave, lies in the fact that they are of sufficiently unusual appearance to create comment that perhaps should not but that does nonetheless embarrass and discourage their wearers. We have eliminated most if not all serious objections of this psychologic nature and enhanced their physiologic effect by making high power lenses of white glass and then fusing to one surface a thin layer of red-free glass of whatever shade desired but of equal thickness and therefore of equal shade and equal effectivity throughout.

Thus is offered not a change in technique nor in basic principle but a refinement in the application of red-free lenses, which have proved their value in so many cloudy media cases.

To this lens may be added, for purely reading purposes, an opaque shield with a 10 millimeter opening and side-shields thus protecting an eye from all unneeded oblique radiations.

SUMMARY AND CONCLUSIONS

(1) This is a very restricted compilation. No attempt was made to cover the subject thoroughly. We cite only sixteen references; whereas one of those cited, Stricker,[5] contains a bibliography of well over three thousand items. Our object was to select isolated phenomena of a varied nature in order to throw light upon our subject from many angles and to indicate how much evidence exists in favor of our suggestion that a heat-absorbing lens be used universally as a protection against the earlier clouding of the crystalline lens that may result from exposure to the invisible and, therefore, insidiously dangerous infra-red radiations that exist in all light and in many sources of heat not raised to luminosity.

(2) The technique of cataract operation has been improved greatly; the methods of retarding cataract after its initial onset have not proved effective.

(3) One obstacle lies in the traditional but unwarranted substitution of the misleading term "prevention" for the proper term "retardation" of incipient cataract.

(4) One step toward surmounting this obstacle lies in recognizing the truth that retarding a cataract *after* it has developed, however little, is but retarding it, not *preventing* it.

(5) That true prevention must begin long before cataractous changes evidence themselves as lenticular opacities.

(6) That true preventive methods call for early cooperation on the part of the patient.

(7) To gain this cooperation it will be necessary for everyone to realize that he, as an individual, faces the possibility, with mankind in general, of developing cataract as surely as he faces the possibility of developing old age, if he lives long enough. Some age faster than others, some develop cataract faster than others, but—

(8) Heredity is no more a factor in cataract than in old age. Neither sex is exempt.

(9) Cataract is on the increase. One outstanding cause is the far more general exposure both in length of time and degree of intensity to the infra-red radiation of all light, natural and artificial, and of invisible radiant energy.

(10) The infra-red radiation just beyond the visible red is far hotter than generally apprehended.

(11) Infra-red radiation coagulates proteins.

(12) The crystalline lens is 35% protein.

(13) Any device that prevents the relatively hot infra-red radiation entering the eye removes a potent cause of cataract.

(14) What is known as red-free glass, strictly infra-red-free glass, does prevent the passage of infra-red light and to that extent helps prevent cataract.

(15) But for true protective and preventive results excessive infra-red light should be kept out of eyes wherever and whenever possible from as early a date as possible.

(16) Red-free, heat absorptive glass, known as Calobar—barring the calorific—is an effective means of applying this preventive principle.

(17) Extensive education of the public is essential to full success but great care must be exercised to prevent exploitation.

(18) Many kinds of green glass will be offered that do not absorb the infra-red radiation.

(19) Genuine heat-absorptive lenses have been used with gratifying results during the past ten years in thousands of cases and not a single instance of harmful effect has been reported.

(20) All such lenses to date varied in density of color in different areas from middle to edge according to the varying curvatures of the lens.

(21) The new Ryer-Hotaling lens overcomes this objection and affords uniform density of shade throughout, and equal protection, by fusing to the correcting lens proper a thin piece of heat absorptive glass of any desired shade with parallel surfaces hence of equal density of shade throughout.

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DISCUSSION

DR. WILLIAM FEINBLOOM: The treatment of cataracts has become so definitely associated with surgery that any non-surgical method provides a boon which cannot be overemphasized. To have evolved an optical device for controlling the development of cataract as well as to act as a preventive has been the valuable contribution to science of our esteemed colleagues, Drs. Ryer and Hotaling.

Dr. Hotaling's work on cataract retardation extending for 15 years is here carried a step further through the development of a new heat absorbing lens. If we take but a moment to trace the course of Dr. Hotaling's former researches in heat radiation as a cause of cataract we must start with his original experiments upon the eyes of fish. At that time with suitable controls certain groups of fish were exposed to different radiations through the use of filters. He proved that radiation beyond 7000 A.U. when prolonged was a cause of cataract. Then followed the Herculean task of securing clinical evidence for testing this effect on human eyes. Yearly reports to the Academy during these past years has resulted in the accumulation of data that definitely suggest cataract control may be accomplished through the use of heat absorbing lenses. Careful analysis of Dr. Hotaling's data in these reports shows a definite increase in visual acuity as the result of the use of these lenses. Some part of the increase in acuity may be due to the dilation of the pupil. From his charting of the opacities it is also evident that another part in the improvement in acuity is due to reduction in the opacities. This is particularly true from the slit lamp studies made in the past three years.

The special form of the red-free glass advocated previously was such that in a flat slab it provided for equal total transmission at all points. When, however, a plus or minus prescription was ground into this glass the necessary element of equal transmission across the whole field no longer existed. Overcoming this problem formed the basis of Dr. Hotaling's investigations the past number of years. The final solu-

tion as presented is the form of lens shown today. By means of adding an equi-transmission filter to any prescription glass we obtained almost an ideal lens for this purpose. The particular filter used by Dr. Hotaling provides even better infra-red absorption than in the old forms.

Drs. Ryer and Hotaling are to be congratulated for this contribution since it is another indication of the effective manner in which optometrists can apply their optical knowledge to a solution of an age old problem which has baffled science since it was first considered.

A PLEA FOR BETTER THINKING AND A SOUNDER BACKGROUND OF PHYSIOLOGICAL KNOWLEDGE FOR OUR ORTHOPTIC PROCEDURES*

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For the past decade, the men of our profession have devised aids and devices, invented techniques and instruments in order that they would better be able to conserve the all-important act of seeing, and maintain a comfortable and efficient ocular set-up. To say that all of these men have succeeded is indeed a fallacy, for there are yet many such methods of procedure which would not stand up under a true scientific inquisition. Too few men have proceeded along lines of scientific investigation of ocular treatment—orthoptics and otherwise—and until such is done and proven, we are apt to be known as quacks by the other professions; not that some of our methods are unsuccessful, for on the contrary in the majority of cases the main thing that we seek is accomplished, i.e., the patient is made comfortable ocularly. But still in order to go further, we have to prove conclusively to all that our methods and ideas are not simply a senseless "brainstrom." Definite data must be shown to the profession so that they themselves may believe in the technique before they try to convert their patients and public. As an example of my latter contention, the group of optometrists who are apparently developing that field of optometry where different visible wave-lengths of light are used for treatment purposes, seem to keep their information to themselves. For the price of approximately thirty dollars, this sacred group will divulge their secrets of treatment and let other wayward optometrists give mankind the benefits of their wonderful discoveries; for thirty dollars they will teach them to lower high blood pressure and increase low blood pressure; for thirty dollars they will teach them to give the world vision; to clear cataractous eyes; and to reduce esophorias and decrease exophorias—to increase our positive corrections and decrease our negative corrections. For the past two years I have been reading our optometric magazines where the wonderful results of using colored lights were spasmodically reported and yet still meager accounts of methods of treatment and scientific bases were divulged. I believe the most interesting material I read on this subject was in the New York Times. Imagine a medical scientist discovering a procedure whereby he could cure cancer, offering to divulge this secret discovery for thirty dollars per head, or a

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Louis Pasteur telling the world he would divulge the cause of millions of deaths—for thirty dollars a head!

To go on with the main thought of this article. For an optometrist, or student in optometry, who wants to practice in the field of orthoptics, the situation is indeed a veritable puzzle. Scores of instruments are devised, some valuable, same valueless; many methods are devised, some valuable, others valueless; and likewise hundreds of theories are propounded, mostly valueless. Valueless because the foundations are poor, the propoundant often ignorant of basic neurological laws and fundamentals.

Many optometrists care not for theories—"we are practical men" they say, "leave your theories and arguments in the class room—this method works." And if it works on Tom Jones and not on Dick Smith—well, "it just didn't work on Dick Smith—something's wrong with him." We should realize that theories are just as important as practicalities in many ways, for if one theory is correct, a great step forward is moved all along the line. I do not set myself up to be a theorist, but knowing some fundamental facts, some ideas we see in print and methods used are foolish, to say the least. . . . Many men practising orthoptics know that the eye moves and something happens . . . they don't realize that the continual motion smooths synaptic pathways, induces a bigger blood supply, which in turn helps to cart away the acids of muscle fatigue and products of oxidation. We speak of fusion and eye fusional movements, but few can actually picture what goes on in the nervous system and muscular division of the ocular system. Some men may ask, "What's the use of knowing such rot?" Possibly if some men propounding ideas in the field of ocular myology would know the so-called "rot," foolish statements and hypotheses would not have resulted, thus increasing the rate of optometric educational advancement.

Far too few optometrists have paid attention to physiology, which is the study of the whys and wherefores of the action and function of the organs of the body. Surely, we practicing orthoptics can gleam much valuable information and material from the work of great physiologists. Their conclusive experiments on muscle and nerve action and fatigue should certainly be our foundation. Let us pay more attention, from now on, not to merely the word "fusion" or "esophoria," but let us think deeper, i.e., let us understand and think of what happens when the eye turns in—why, does the individual feel tired, why the headache and discomfort? The answers are not low ductions and strain, but possible lowered muscle tone, accumulative toxic end-products of fatigue, fatigue of nerve synapses, etc. Physiologists before us have devised ways of combatting such effects, for instance, heat to increase blood supply, rest—to let the muscles regenerate their chemistry, exercise to increase tone and circulation, stimulation by physical contact (massage) to increase the blood supply and bring more oxygen to the tissues—and carry away the acids of fatigue—couldn't a few of these ideas be investigated scien-

tifically in optometry—not haphazardly. Some of these are performed by our ordinary orthoptic treatment—but if so, let us understand them, and why and how they occur. Many useless procedures could beneficially be done away with, for the betterment of ourselves and our patients.

I would like to enumerate a few principles of elementary body myology, which does not differ radically from ocular myology. During the discussion, a few seemingly wayward points may be mentioned which will, in time, be seen to have a bearing on our case.

It is a known fact that every living organism contains carbon, hyrogen, oxygen, sodium, sulphur, phosphates, chlorides, potassium, calcium, magnesium and iron.

Movements of muscles in the body are generally responsive to a change in the central nervous system, which in turn has been brought about by a change in the environment of the individual. All movements of the eyes, therefore, whether due to extrinsic or intrinsic factors, are due to a change in stimulus, usually due to the changing position of light objects which are actually or artificially moved on the retina. This movement, then, resolves itself into a reflex action—thus involving an afferent nerve (sensory nerve), the central nervous system, an efferent nerve (carrying impulses away from the central nervous system) and the effector muscle itself.

We shall try to give in as simple as possible a brief explanation of the factors involved in these movements as they especially relate to the eye. If an object be situated to the right side of the head (the eyes primarily directed straight ahead); if the attention of the individual be called to the right side object—the following things happen. The media of the eye having focused the object on, let us say, the left-hand retinae of both eyes (which sides will therefore be stimulated more than the right-hand halves), the impulse thus travels to the primary optic centers (external geniculate bodies) and hence to the cortex; but since the impulses reaching the left-hand cortex are stronger than those reaching the right —the new motor impulses thus aroused in the cortex will reach the third, fourth and sixth nerve nucleus of the same side and the eye will turn to the right—which causes the centers of the object to fall on the foveae, thereby resulting in single vision.

To continue. There are three varities of muscles in the body. They are striped voluntary muscles, plain involuntary muscles, and cardiac muscle. The extrinsic ocular muscles of rotation are voluntary in that they are striated and are directly controlled by the central nervous system. The intrinsic muscle or ciliary muscle is unstriated and has a nerve supply which has a nerve ganglion interceding between the central nervous system and the effector muscle. Basically, the ciliary muscle is involuntary, but it has some connection with the cortex as it in many cases can be controlled voluntarily. The anatomical differences between voluntary and involuntary muscle are important in ocular work as will be

seen later—the reader should get a good basic understanding of the subject by reading a good book on physiology.

The ocular muscles are connected with the central nervous system by nerve fibers, some being afferent (bringing stimuli from the muscles to the central nervous system), some efferent (carrying impulses from the c. n. s. to the muscles), and also some sympathetic fibers of unknown function. These fibers (motor) end in the muscle substance itself by way of the end-plate.

So that we may understand the physiologic activity in muscles and nerves during contraction, it is essential that we go at least superficially into the chemistry of muscle. The muscle plasma or semi-fluid contents of muscle fibers contains mostly proteins. There are other substances found in muscles, namely, (1) Coloring matter (haemoglobin); (2) Nitrogen extracts; (3) Fats; (4) Glycogen; (5) Glucose; (6) Isitol (a muscle sugar); (7) Inorganic constituents as water (75%), potassium, phosphoric acid, and traces of carbon, magnesium, chlorine and iron.

During contraction the glycogen present in the muscle is transformed to lactic acid (under exertion). Any movement of the body, muscular or mental, causes changes in cells—with transformation of energy. "The original source of energy possessed by the animal is the chemical energy of the substance taken in as food. In any of these changes there is neither destruction or creation. There may be conversion, but no loss." When the extra-ocular muscles contract, as in the ductions tests, the whole muscle involved does not contract at once—contraction usually begins at the insertion of the nerve at the muscle and spreads in both directions throughout the muscle. At this time, the volume of the muscle does not change, but each muscle fiber and the whole muscle becomes shorter and thicker.

In the ordinary muscles of the body—continued and repeated stimuli resulting in successive contractions, eventually reaches the stage where we have a tetanus (continual spasm), occurring. Various muscles have various time limits or number of contractions depending upon the chemical and nervous constituents of the muscle concerned. Thus since continual contractions are detrimental to the muscle itself—why in our orthoptic methods do the majority of optometrists give rotatory and excursional exercises or accommodational exercises without paying any attention to the time limit and in most cases prolonging the exercises over an extremely long period. Many men will leave their patients ("with the automatic exercisers") as long as 20 minutes to a half hour without rest. Instead of benefitting the condition, by our action we are doing the contrary. The continual collection of lactic acids and other fatigue products of the muscle and nerve simply creates a further fatigue so that in many cases the person is worse off than before. While it is true that the extra-ocular muscles seem to be able to do more work than other muscles of the body without as apparent a catabolic change—never-

theless we should let our patients rest much more oftener, and continue the exercises with only about five-minute intervals and sometimes less, that is, five minutes of exercises, five minutes of rest, etc. During the rest period the patients should be instructed to do nothing but close their eyes and occasionally blink; a little massage at this time would also be extremely helpful so as to hasten absorption of the end-products and promote good circulation. Naturally, muscles of any part can not go on contracting indefinitely. Sometimes it seems so in the case of the extra-ocular muscles when some patients seem to be able to continue without subjective reports of fatigue discomfort. But nevertheless there are detrimental changes with long periods of contraction. The excitability of the ocular system is reduced (latent period longer), work is diminished, nerve fatigue at point of muscle insertion, and other changes occur. At some time the muscle or muscles involved do not return to their original length. Artificially outside the body, muscle recovery is hastened by a salt solution, in the body it is hastened by rest, improved circulation—which can be obtained by massage and heat.

We should remember that fatigue is dependent upon two factors: (1) "Consumption of the substances available for supply of potential energy to contracted material." (2) "Accumulation of products of the contractile process." The length of time each patient should have is difficult to say exactly but should depend upon their health, appearance, and subjective report as the exercises continue. Since in orthoptics we are also (if not more) interested in creating flexible and easier nerve pathways (not large muscles), nerve coordination and smoothness of synapses, this should be all the more reason for smaller periods of exercises—as nerve ends and nerve synapses tire more rapidly than muscles.

Under usual conditions the muscular contractions ocularly are brought about because of a reflex—or in response to some stimulus descending from the cortex (voluntary contractions). In our orthoptic period—we usually have a reflex condition—that is, stimulation of some part of the retinae of both eyes by images of an external object sets up a nervous reaction whereby the eyes in order to avoid diplopia have to rotate. Thus the greater and more interesting the stimulus to the individual, the greater will be the response or the effort to respond. In orthoptics we are really conditioning certain nervous pathways more than others, so since memory is a great help in reconditioning, a vivid and interesting stimulus is more productive than an uninteresting one. Hence more vivid methods of exercise and more interesting charts in conducting treatment.

It is a known fact that the slower the speed of contracting and relaxing of muscles, the more the amount of work accomplished. The slower the contraction, the more energy used, and therefore more fatigue elements. So naturally if our orthoptic machines travel at a very slow rate—it follows the more slower the rate of motion (under certain conditions) the faster the rate of fatigue. This may be another element in

considering the length of the exercise. Continuing a very slow rotation for the length of time some of us have been doing with our patients, there will be some point reached where the extra energy required to maintain contractions, more than compensates for the gain in work achieved by increased time of the contractions. Thus for each set of muscles there will be an optimal length of time these muscles will perform their work with the greatest economy. This whole latter idea can be understood more readily if we picture a gymnast climbing a rope—the slower he climbs (up to a certain speed) the less will be the effort, but if he climbs too slow, the effort will be more tiring.

Temperature has an effect on the mechanical responses, but since at the present these principles (heat) are seldom used by the optometrist, we shall not go into it in detail except to state that warming a muscle tends to quicken its activities—and cold has the reverse effect, making muscles less excitable. Possibly some method could be devised to aid treatment in our optometric procedure—to use these basic principles.

We next come to a rather important point. Physiologists claim that the central nervous system can respond or "attend" to only one thing at a time. ("Every effective reaction inhibits every other reaction.") Starling puts it in this manner: "As a rule if two stimuli be applied simultaneously at different points, the reaction which ensues will not be a combined one—the resultant of the reactions which would normally be conditioned by each single stimulus, but will be a response to one of the stimuli, which we must therefore regard as the most effective. The reaction to the other stimulus is either abolished or comes on after a considerable period of delay." This fact then brings up the question of the value of plus lenses combined with prisms base in to relax accommodation and all such procedures where we are using two objects of stimulation together to effect one result, either stimulus alone being capable of creating the reaction; as we believe of base in and plus lenses. Thus without scientific investigation it should seem by the above statement, that a faster result would be obtained by using only one stimulus at a time—possible the using of the two together simply hindering the result because of more nerve resistance—the nerve resistance due to fatigue of the two pathways, instead of one if we simply performed or used one reflex at a time. Further thought should be gone into relative to this matter.

Muscles themselves of course, are not the only implements by which we obtain ocular movements—nerves also are involved.

Nerves fatigue more rapidly than muscles—this physiologic fact being extremely important in our work. To diverge a while, let us understand what a synapse is: a synapse is a nervous connection, or a point where an impulse is transferred from one nerve fiber to another (axone to dendrite) or the ending of a fiber around another nerve cell. Naturally the ocular system, as the rest of the body, is connected to the c. n. s. by means of synapses. To go on *"Passage of a nerve impulse across a synapse, or series of synapses, has a two-fold effect. If the passage be too*

often repeated, phenomenon of fatigue are produced and there is an increase of block (or resistance) at each junction of synapse. If, however, the stimulus be not too excessive, and the reaction not too frequently evoked—the effect of the passage of an impulse is to diminish the resistance so that a second application of the stimulus elicits the reaction more easily. The process of summation, in fact is chiefly in removal of the block or resistance. *When an impulse has passed through a certain set of neurons to the exclusion of others, it will tend, other things being equal, to take the same course on a future occasion and each time it traverses this patch, the resistance will be smaller."* So we are therefore going through a learning process in our orthoptic treatment. The paths of the nerve impulses are made more facile so that the future usage of these passages will assure efficiency and comfort.

The point in the nerve-muscle that suffers from fatigue first is at the junction of the nerve fiber and its insertion into the muscle. However, in the ocular set-up since we have more than one synapse in the nerve pathway, fatigue may be brought about much faster.

It is known that excitation of a muscle or nerve causes fatigue which naturally creates a hindrance to our repetition of the same movement: it is also known that inhibition which is a large part of every reaction, is followed "by a condition of increased excitability or diminished resistance to the passage of impulses. In each case there is a tendency for a 'swing-back' to take place from excitability to overexcitability." During the years 1934-35, Dr. W. J. Tait conducted a series of experiments using base in treatment. It was found as a result, surprisingly, that the *adduction was materially increased in practically every individual, instead of the abduction which was the reflex being trained.* This naturally seems rather puzzling (if we heed our older principles), but possibly it can be explained somewhat by our former statement—abduction is the reverse of adduction; is it not possible that we consider abduction the inhibition temporarily of the turning in of the eyes? This constant inhibition, then, according to physiologic beliefs, should arouse a corresponding overexcitability of the opposite reflex or in this case increased adduction—as occurred. This experiment then gives us valuable food for thought—and shows that possibly we can often hasten the production or easier nerve response to one ocular reflex by stimulating the opposite—paradoxical as it seems. It would be interesting to know, in Dr. Tait's experiment whether the high ductions obtained at that time, still exist. How many of us have had patients where base in prisms give a patient with esophoria extreme comfort, paradoxically as it seems. Further experimentation should be done along this line, on all ocular reflexes.

Questions as to the reasons for sudden complaints of hypermetropes, astigmatic individuals, etc., who apparently up to the time of their asthenopia, never had any trouble, have also occupied my mind. It would be interesting to see what other men in the field attribute the causes to.

In ending, it is my hope that this informal article, basic as it is, will do its part to stimulate the minds of many practicing orthoptists and optometrists to study further the interesting subject of physiology and correlate their study with their daily practice.

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REPORT ON THREE CASES OF PROGRESSIVE MYOPIA AND ONE CASE OF HYPERPHORIA*

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In this paper I am presenting particulars of several difficult or out-of-the-ordinary cases. Some have been dealt with successfully; others have been frankly disappointing—but I have not hesitated to give details of these because only by acknowledging failures may other practitioners benefit in the future.

First of all I present three cases of progressive myopia for your consideration.

Case No. 1. Master P. Aged 15 years.

He had visited an ophthalmic surgeon in June, 1932, who prescribed:

O.D. —9.25 Sph. ⌒ —1.25 Cyl. Axis: 10.
O.S. —6.00 Sph. ⌒ —1.50 Cyl. Axis: 140.

This prescription was uncomfortable and the patient was constantly giddy. He was again taken to the surgeon in 1933, who then prescribed:

O.D. —9.50 Sph. ⌒ —1.25 Cyl. Axis: 40.
O.S. —6.00 Sph. ⌒ —1.75 Cyl. Axis: 145.

This prescription was no more comfortable than the first. The boy had developed an anxiety neurosis due to the condition. Physically and psychologically he was retarded.

On January 4, 1933, I examined him:

Vision O.D. Count fingers at 18 inches.

Vision O.S. Count fingers at 39 inches.

Prescription found:

O.D. —11.00 Sph. ⌒ —2.00 Cyl. Axis: 20 ⌒ 2 △ base-up. Which gave vision of 9/18.

O.S. —7.00 Sph. ⌒ —1.00 Cyl. Axis: 160 ⌒ 2 △ base-down. Which gave vision of 9/18.

For reading I gave a +3.00 addition in cement bifocals.

February 6, 1933: Base-in orthoptic exercises were commenced, following which it was possible to give a 6 △ base-in over each eye.

*Submitted for publication May 29, 1936.

These were fitted in a "clip-over" for constant use. In addition, calcium lactate tablets were ordered.

May 17, 1933: I rechecked and found exactly the same conditions all through.

October 5, 1933: I reduced the prescription by 1.00 Sph. in each eye: this gave a vision of 9/12. So far I was extremely optimistic—progress had been made!

May 18, 1934: A further check on this date showed that the left eye had got a little worse. The lens in front of this eye was changed to:

O.S. —7.50 Sph. ⌒ —2.00 Cyl. Axis: 170 ⌒ 2 △ base-down.

October 10, 1934: Rechecked—no change.

October 18, 1935: Rechecked—no change.

The boy had grown quickly during this year and had also developed mentally. His mother was delighted with this and considered it was entirely due to his ophthalmic treatment.

July 29, 1936: The right eye showed no change, but the myopia in the left eye had again increased a little to:

O.S. —8.75 Sph. ⌒ —2.00 Cyl. Axis: 170 ⌒ 2 △ base-down.

He now showed a distant phoria of 14 Exo. in addition to the hyperphoria and an abduction of 9.5. Moreover, when looking through the reading segments, or the equivalent prescription mounted, he also showed 14 Exo. A 4 △ was incorporated, base-in, in his prescription.

Conclusion

The "damage" was mostly done before I had control of the case, but I think that the treatment has been of enormous help here. Since I first examined him, the patient has been reading more than ever before so I have been up against the greatest difficulty, and taking this fact into consideration, I am well pleased with the result. I am not prepared to say which of the treatments benefited most, the calcium or the base-in technique. The case is submitted on its merits.

Case No. 2. Master L. Aged 15 years.

First seen in 1932. Had never worn spectacles, and found that he could not see well. My prescription was as follows:

O.D. —5.25 Sph. ⌒ —0.75 Cyl. Axis: 35.

O.S. —5.50 Sph. ⌒ —0.75 Cyl. Axis: 160.

Distant abduction: 8. Recovery: 6.

6 △ given in clip-over in addition to +3.00 reading segments in his bifocals.

In April, 1934, I again saw this patient, and found:

O.D. —5.75 Sph. ⌒ —1.00 Cyl. Axis: 35.

O.S. —6.00 Sph. ⌒ —0.75 Cyl. Axis: 170.

Calcium lactate was now ordered. In the interim period he had been working hard at a public school intending to enter the medical profession.

September 13, 1934: Rechecked—no change.

July 24, 1935: The calcium lactate had been left off for some six months and the defect had now increased as follows:

O.D. —6.50 Sph. ⌒ —1.25 Cyl. Axis: 25 ⌒ 2 △ base-in.
O.S. —6.75 Sph. ⌒ —1.00 Cyl. Axis: 165 ⌒ 2 △ base-in.
For near work:
O.D. —3.50 Sph. ⌒ —1.25 Cyl. Axis: 25 ⌒ 4 △ base-in.
O.S. —3.75 Sph. ⌒ —1.00 Cyl. Axis: 165 ⌒ 4 △ base-in.

This has become constant and stabilized. In this case I do feel that the optometric treatment was second in importance to the calcium treatment.

Case No. 3. Master R. Aged 13 years.

I saw this boy in September, 1933.
He was wearing:
O.D. —4.50 Sph. ⌒ —1.00 Cyl. Axis: 35.
O.S. —3.50 Sph. ⌒ —1.00 Cyl. Axis: 170.
I found:
O.D. —5.50 Sph. ⌒ —1.00 Cyl. Axis: 35.
O.S. —5.00 Sph. ⌒ —2.00 Cyl. Axis: 170.
Add for near work: +2.50.

I also prescribed a prism clip-over with 4 △ base-in in each eye, and put him on calcium lactate.

April 24, 1934: Rechecked—no change.
October 27, 1934: Rechecked—no change.
February, 1936:
O.D. —6.00 Sph. ⌒ —1.75 Cyl. Axis: 38 ⌒ 3 △ base-in.
O.S. —5.75 Sph. ⌒ —2.00 Cyl. Axis: 160 ⌒ 3 △ base-in.
Add for near work: +2.50.

He showed 3 Exo. for distance, with 8 abduction, and for near: 2 Eso. but 6 Exo. with the reading addition. (This is due to the habit of wearing the prisms.)

September 25, 1936:
O.D.—As before.
O.S. —6.00 Sph. ⌒ 2.75 Cyl. Axis: 160.
But patient accepts binocular addition of +0.50.
March 6, 1937:
O.D. —6.00 Sph. ⌒ —2.50 Cyl. Axis: 35.
O.S.—No change.
(With the binocular addition the above sphere is 5.50, of course.)
This case is still under observation.

Conclusion

I am aware that some optometrists do not themselves prescribe calcium, but it will probably be of interest to see these results from one who does, and to hear his opinion.

I am of the opinion that both techniques should be adopted, and from my experience with these cases and others, I think that in some cases the optical technique alone definitely benefits, in others it has little effect. The calcium treatment also benefits some cases (refer to Case No. 2) and in others appears to have very little effect.

With a knowledge as limited as it is at present, I feel we should adopt both treatments if possible, together with any others which may be developed, in order to arrest the development of the distressing complaint—progressive myopia.

Hyperphoria

I always think a hyperphoria case interesting. It always amazes me to come across, say 6° of hyperphoria which may cause no symptoms at all and both eyes work well together, with no suspension, as far as one can tell, whereas another individual may present symptoms of migraine and even vomiting, with 1° of hyperphoria. These things are, of course, relative. Some types are "highly strung," others are phlegmatic; some can cope with amazing 'phorias with no duction reserve to neutralize them, whilst others need an intensive course of duction development to build up at least a three to one reserve to ensure comfort, but hyperphoria is different. At least, I have always considered it so, but here is a case which I had a few weeks ago:

Miss J. Aged 55 years. Consulted me on May 1, 1937. It was four years ago since the last ocular examination and the patient complained of near vision "difficulty" and orbital pains (i.e., common symptoms of ametropia and presbyopia).

Here are the findings:

O.D. Vision 9/18. +1.00 Sph. ⌒ —0.50 Cyl. Axis: 70. 9/9.

O.S. Vision 9/18. +1.25 Sph. ⌒ —0.50 Cyl. Axis: 115. 9/9.

This showed 5° of Eso. for distance combined with 9° of right hyperphoria. With a reading addition of 2.25, 6° Exo. was manifest. I incorporated 4½ △ base-down in the right lenses and 4½ △ base-up in the left lenses in the final prescriptions.

The binocular poise, as manifest with the diploscope, was at once perfect, and the patient, so far as I know, has been comfortable ever since. The patient took to this prescription straight away without any orthoptic exercises or any period of readjustment on account of the corrected hyperphoria.

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THE GENERAL AND OCULAR FATIGUE PROBLEM

I. *Introduction*

A. The fatigue problem is given much consideration and study in the office, factory, laboratory and refraction room. That it is a problem of vital importance is admitted by all students and practitioners who come into contact with biological problems. In many factories, offices, and department stores, special investigators are at work studying this complex subject. In these places the subject of general fatigue is being studied and with some degree of success. As optometrists we are naturally interested in the subject of ocular fatigue. Unfortunately, ocular fatigue does not lend itself so readily to investigation and experimentation as does general fatigue. In fact, very little is known definitely about this subject. When one considers the lack of factual information upon this subject, one is greatly surprised to hear some lecturers or writers make the statement that in certain refractive cases the "fatigue pattern must be either inhibited or equalized" before the patient will feel comfortable. We recall that one lecturer discussed at great length the case of a woman patient who complained of all the ocular symptoms one might find in any good book on symptomatology. He gave a lengthy list of some exhaustive test he performed and concluded that the main trouble

was caused by an unequal fatigue pattern and in order to equalize the fatigue patterns he changed the lens in one eye from a + 0.25 D. Sphere to a + 0.37 D. Sphere and with this change in the prescription the patient was relieved of all ocular symptoms she complained of before. Now this sounds very interesting, but the question that presents itself is this: (1) How do we know that ocular fatigue was causing the symptoms, (2) what method was used to measure the fatigue, (3) how was the presence of an unequal fatigue pattern determined, (4) what method was used to determine that the increase of the power of one lens by + 0.12 D.S. will exactly equalize the fatigue patterns, and (5) what proof have we that the relief was the result of the small increase in the lens power?

The writer fully realizes that these questions can not be answered readily because of our present lack of knowledge of the subject. In order to get to the problem of ocular fatigue, it is essential that we first have a clear understanding of the mechanism, symptomatology and causation of general fatigue. We shall therefore try at first to discuss this subject fully: To know and understand the fatigue problem we must know: (1) What fatigue is, (2) how it is produced, (3) where is it located, (4) how can we measure it, (5) is it general or ocular and (6) how can it be removed?

II. *What Is Fatigue?*

A Fatigue, claims Spaeth[1] is a decreased capacity for performing work, resulting directly of products of activity and varying with the duration, rate and intensity of performance and the initial strength or capacity of the physical system involved.

There are several theories advanced to explain the fatigue mechanism, the one most plausible is the theory of chemical equilibrium. It is an established fact that organisms have the power of self-recuperation. This is in contrast to the man-made mechanical machine, which can not replace by itself the wear and tear of its parts. The organism has a double process of metabolism. (1) anabolism, which is the building and constructive process and (2) catabolism which is the destructive and tearing down process. These two processes of metabolism constantly tend to balance each other, this is called *physiologic equilibrium*. The relation between work and rest can thus be explained as follows: When work is started the energy potential is high; as the work continues the energy potential becomes low, fatigue then sets in, and as we rest a reaction in the opposite direction takes place, etc. The tendency to deposit energy at a high potential is developed. This explains why muscular work cannot be continued indefinitely, and after a certain period of work we must rest, and after we rest we find that energy has returned to its former high potential. Fatigue may thus be considered to be protective mechanism.

1. *Fatigue Characteristics*

Mosso[2] is one of the pioneers in the study of fatigue. He performed many ingenius experiments on this subject. He states that a muscle separated from the body will give many contractions one after another with great regularity. As the contractions follow one another their height diminishes as the fatigue increases and continue to diminish with regularity until the contractions disappear. As fatigue increases the contracted muscle fails to relax to its original position and we then get a contracture, irritability decreases as fatigue increases. The refractory period (the period between two stimulations, during which a nerve will not respond to a stimulus which is normally .005 of a second, may be prolonged to one second when the muscle is fatigued or when there is a deficiency of oxygen).

The general fatigue characteristics are briefly:
(a) The contraction curve becomes higher at first: "treppe."
(b) Retardation of contraction curve.
(c) Increase in relaxation time.
(d) Contracture.
(e) Decrease in response.
(f) Prolonged reactory period.
(g) Increased reaction time.

There is a considerable difference between general body fatigue and brain fatigue. The brain fatigue gives the following characteristics:
(a) Weak pulse.
(b) Head becomes hot.
(c) The eyes bloodshot.
(d) The feet cold.
(e) Disturbed digestion.
(f) The ability to spell correctly is reduced, and one leaves out words in writing.
(g) Headaches accompany brain fatigue.
(h) Loss of ability for self-control.
(i) There is a change in temper, and one becomes more irritable.
(j) Loss of ability to carry on intellectual work.
(k) Decrease in attention power.

2. *Types of Fatigue.*

Fatigue may be either central or peripheral, involuntary or voluntary. We have central fatigue when a series of voluntary efforts result in failure of muscular response, i.e., after lifting repeatedly a certain weight with the finger, one tries to lift it again but fails to accomplish the act. If an electrical stimulus is then applied directly to the body of the muscle or to the nerve trunk a contraction is again elicited. When the point is reached when we get no contraction from applying the stimulus directly to the muscle then we have *peripheral fatigue*. When central or voluntary fatigue sets in, the muscle is still able to do much work when

it is stimulated peripherally. This is not an hypothetical statement. It is a fact proven repeatedly by exact laboratory experimentation.

B. How Is Fatigue Produced?

When the metabolic processes of katabolism and anabolism function properly we can not have fatigue because the tearing down process and the building up process balance each other. Only when the activity of the muscle is so rapid that there is not sufficient interval between successive stimulii do we get fatigue. When a muscle is successively stimulated the resulting contractions produce lactic acid, in addition carbon dioxide and potassium phosphate acid, carrying hydrogen ions are also liberated during muscular contraction. The sources of energy, (a) the carbohydrates, (b) fats, and (c) proteins, are used up. The heavier the muscle activity the greater is the draft upon the carbohydrate material reserves in the body. Because they are easily assimilable carbohydrates furnish the readiest form of energy available and with the decrease of this material fatigue begins to set in.

1. *The Causes of Fatigue*

These may be enumerated, according to Drinker[3], briefly as follows:

(a) The continued muscular exertion especially at a rapid rate which consumes the carbohydrate and fat reserves and produces lactic acid.
(b) Maintained use of intelligent observation with varying degrees of muscular effort necessary in every kind of work.
(c) The steady concentration upon a skilled kind of task.
(d) Excessive mental effort.
(e) Disturbed attention, for example, when several tasks are to be attended at the same time.
(f) The continued use of the same sense organ, such as in discrimination by sight.
(g) A change in chronaxia or increased refractory period.
(h) Change of temperature, moisture, climate, season, interest, monetary considerations, social and home conditions.

From the last few factors enumerated it may be seen that not all fatigue factors are of the physiological nature. Some of them are of a distinctly psychological character.

It is advisable for the optometrists who take their work seriously, especially those interested in orthoptics, to make a special study of the fatigue problem, its causes and symptoms. A thorough knowledge of this subject may help explain the reason for failure to get results from orthoptics in some cases.

C. *Where Is Fatigue Located?*

The next question of importance is when we have fatigue, we want to know what is fatigue and where is the locus, i.e., the site of fatigue. Is the fatigue in the muscle fibers? the nerve fibers? the neuron bodies?

Myo-neural junction? Experimentally it was proven that the neuron bodies are not sites of fatigue. Sherington in his studies has shown that fatigue is not in the nerve itself, but in the synapse. The increase of lactic acid due to muscular contraction increases the synaptic resistance, i.e., it produces a block so that the nerve impulse cannot jump across the synapse and when the nerve impulse cannot pass the synapse the muscle will fail to contract. To overcome this block we have two alternatives, (1) to increase the strength of the impulse so that it may break down the synaptic resistance, (2) to experience some sudden general influence which lowers synaptic resistance, thus permitting the normal impulse to pass through and reach the muscles.

This will probably explain the reason why in some cases with low ductions, where we find it impossible to raise the duction power with the usual orthoptic technic, a considerable improvement is shown after several applications of high frequency and diathermy currents.

Another site of fatigue is the myo-neural junction, i.e., the motor-end plates. This operates like a synapse where the nerve impulse is completed and passes from the nerve fiber to the muscle cell. Both the synapse and the motor-end-plate act as a double safeguard against complete exhaustion. The first acts within the central nervous system, the second acts as the peripheral safeguard.

III. *Fatigue Tests*

A. Methods for measuring fatigue are numerous. Their technic varies as does their reliability. Some of these methods attempt to measure fatigue directly and other indirectly. Some of these indirect methods aim to measure the energy output in men. They are:

1. Calorimeter method.
2. Calculation from his diet.
3. Measuring the oxygen used up by the subject.
4. Measuring of amount of lactic acid produced.

The efficiency of a mechanical device can be calculated if we know the amount of work done and the amount of energy used. The mechanical efficiency = the mechanical work done.
total energy used.

The mechanical efficiency of a human subject with which he performs a given task can be calculated if we know the work he does and the amount of oxygen he uses.

Human efficiency = work in foot pounds (oxygen consumption in litres) 1,580.

A man consuming 1 litre of oxygen per minute is liberating the total energy at the rate of 0.481 H.P., while a man of 147 pounds consuming 4.38 litres of oxygen per minute liberates the total energy amounting to 2.1 H.P.

The methods listed thus far are utilized mostly in laboratory work and are not adaptable for practical application.

B. *Practical Methods for Measuring Fatigue*

1. Martins Spring Balance Test.

This apparatus is an ordinary flat-faced spring balance with a scale capacity of 200 pounds, marked with two-pound units, equipped with a self-registering index.

2. Work Output Test.

Comparison of work output at the beginning and end of the work shift.

a. In the easy job the showing is better at the end of the shift than at the beginning.

b. In moderate exertion jobs the stronger worker will do better at the end than at the beginning, the opposite will be true of the weak worker.

c. In the difficult tasks all workers do not do as well in the end as they did at the beginning.

3. Dynamometer. This consists of a steel spring in the form of an ellipse somewhat different from Martin's Spring Test. It is taken in hand and compressed in such a way that the pressure approximates its two curves in the line of the minor axis. The force of the hands pool is indicated by deviation of a little pointer upon a graduated scale.

4. Dynamograph. This is an instrument registering the strength of the contraction. The main defect is that it does not furnish a constant indication.

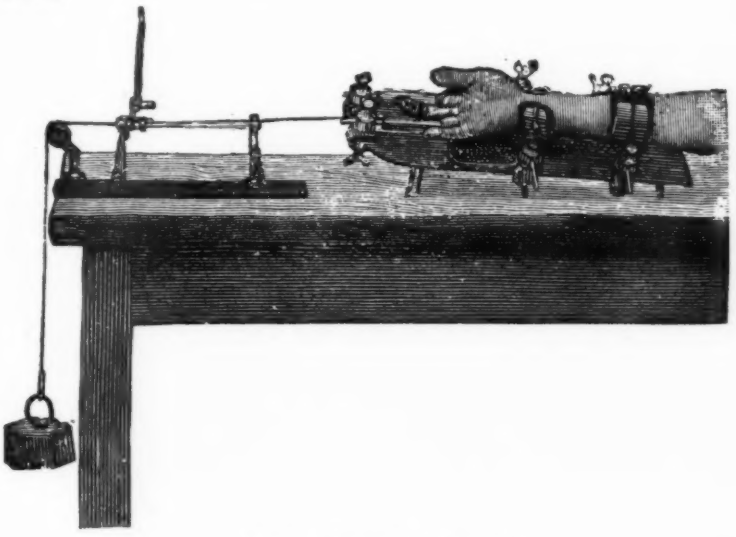


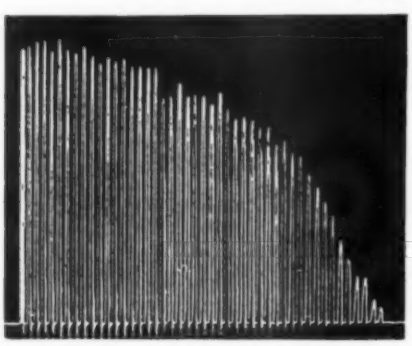
Figure 1 Ergograph (Mosso)

5. Industrial accidents. Here the number of accidents that occur are studied as well as the time of the day they take place. It is contended that when people are fatigued they are subject to accidents.

6. Lost time and sickness. It is claimed by some that sickness is the extreme stage of fatigue with a few and a diminished working capacity with the many.

The Ergograph. With this instrument, as illustrated in Figure 1, it is possible to register the work done by a muscle. It is composed of two parts. One keeps the hand fixed and the other registers the muscle contraction. It will be noted that the hand is so placed in the ergograph that it remains fixed. A cord connected with the weight is fastened to the second phalanax of the middle finger. When this finger is flexed it raises a weight. With each flexion of the finger a mark is made on a smoked drum registering the height of every contraction. Figure 2 is a typical normal fatigue curve tracing. It will be noted that the first line to the left designates the contraction power of the muscle at the beginning of the experiment. The second, third and fifth lines are somewhat progressively higher than the first. This is characteristic behavior of the normal muscle. At first it shows improved efficiency, then the efficiency begins to decrease as is shown by the gradual fall in the height of the succeeding lines until finally the muscle becomes completely fatigued and then when it can no longer contract and the tracing becomes a straight horizontal line.

Mosso[2] claims that the fatigue curve differs in different individuals. We can read the characteristic differences shown by different subjects in their resistance to work. The ergograph gives us an individual record as to how we develop fatigue and this record will remain constant. As an example we may compare the fatigue curves, Figures 2 and 3. Each one



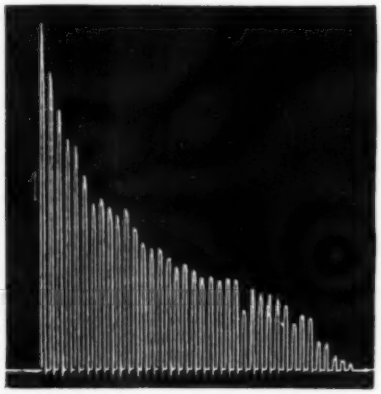


Figure 2—Normal fatigue Curve (Mosso) Figure 3

of these represents the fatigue curve of a different person, both of them normal in every respect. They were taken under the identical experimental condition. That is, raising the same weight and following the same rhythm of two seconds.

The tests enumerated are only a few of the great number of tests utilized in the study of fatigue, both in the laboratory and in the field of practical application, but these will suffice to indicate the complexity of the great problem one is confronted with when he attempts to study and investigate fatigue.

Many scientists and investigators have spent much time and effort studying this subject and they realize only too well how little we know about the general problem of fatigue. Hundreds of articles, research reports, and many books have been published on this subject. Most of these contribute something definite toward the ultimate solution of this important problem. Optometrists will do well to familiarize themselves with the work that is being done, to learn all there is known about the physiological and psychological factors which enter into the production of fatigue and into its removal. Some of our readers may object that all this information given in this discussion has no practical application in the refraction room. This is true to some extent, but there is one thing we must not overlook and that is this: that in the study of general fatigue certain facts have been found out about the physiological, pathological, chemical, and physical behavior of certain voluntary and involuntary muscles as well as their nerve supply. These facts and principles hold true about the muscles and nerves of the eyes as well as those found in any other part of the body. A knowledge of these physiological and psychological facts may be of great help to us in handling some of the difficult problem cases. It may offer us a scientific approach to our orthoptic cases. May we suggest to the reader that the paper, "A Plea for Better Thinking and a Sounder Background of Physiological Knowledge for Orthoptic Procedure" by Zevin be studied in connection with this paper on fatigue, as Dr. Zevin's paper, which appears elsewhere in this issue of the Journal, contains a wealth of valuable information on the subject of basic physiology which is so essential in the study of the fatigue problem. Next month we shall continue our discussion covering the subject of ocular fatigue. Jack I. Kurtz.

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SPECIAL REPORTS

ON PRESENTING OPTOMETRIC FEES*

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Is there a right and wrong way of presenting a professional statement? Can two bills for the same amount be presented, say to A and B,

with A well pleased and B feeling he has been overcharged?

In a recent issue of this Journal (June, 1937) is a very excellently prepared report on Optometric Fees by Herbert S. Player, Opt.D., of Stockton, California. The paper shows thought and careful analysis but unfortunately I cannot agree with the author's conclusions. While from a purely professional standpoint his sample statement which I take the liberty of reproducing below, is irreproachable, I feel that the effect on a patient would be opposite to that planned by its author.

June 13, 1937

MR. JOHN SMITH
Stockton, Calif.

PROFESSIONAL SERVICES RENDERED:

Examination, orthoptic training, etc.		$9.00
Optical Materials at Laboratory Cost:		
Frame	$3.10	
Precision Lenses	2.55	
Handling Charge	2.00	7.65
TOTAL		$16.65

We can often render a more correct judgment in viewing a problem objectively. As I write I have before me two bills which I asked my dentist to prepare for me.

EXHIBIT A

Harris Gruman — June 22, 1937
Lebanon, Pa.

PROFESSIONAL SERVICES

2 Visits $10.00

EXHIBIT B

Harris Gruman
Lebanon, Pa.

PROFESSIONAL SERVICES $10.00
1 molar filling
1 bicuspid filling
1 incisor filling
Scaling and prophylaxis

*Submitted for publication June 22, 1937.

Exhibit A is professional beyond reproach. Exhibit B is also strictly professional and for the same total as A. Which gives the impression of good service combined with reasonable charge? Then why not expect the same effect on optometric patients?

Too often in endeavoring to secure favorable patient reaction, we secure a negative result. Let us look at Dr. Player's statement. I fear that it is so extremely professional in its endeavor that the results become negative.

How does Dr. Player arrive at his form of optometric accounting? He states: "When a client consults his attorney there is no consideration given to the amount of paper consumed in reports and briefs, nor is the wear on the typewriter a factor in setting the fee." In this, I agree wholeheartedly. Even your shyster lawyer has to charge for services (such as they are) for that is all that he delivers. The cost of the document itself is so well known to all that naturally it is impossible to make a charge for that.

"When a patient consults his physician," says Dr. Player, "the medical supplies used in the treatment are a minor consideration." I agree again. But when a physician does his own dispensing of supplies such as braces, crutches, rubber stockings or glasses, he charges for all these things as such—and not at cost either. Read Medical Economics (you can usually induce a friendly physician to lend you a copy) and you will be surprised to learn that Medical Grass is no greener than the Optometric variety.

As I glance at Dr. Player's bill, presented to imaginary Mr. John Smith, I try to visualize the reaction of said Smith. Placing myself in his shoes I would say that a fee of $9.00 for examination and a few orthoptic training periods is rather high. On the other hand $7.65 for a pair of glasses is about the usual price, for isn't that what I saw advertised in the newspapers of my city?

"Glasses complete including frame, lenses, examination and case, $7.50."

So the only difference to my untrained lay mind between Dr. Player's careful professional work and the glasses advertised, is a service charge of $9.00. Ridiculous? Idiotic? Stupid? Yes, but true. Besides Mr. Smith, if he is of average intelligence has heard that the usual price for a GOOD frame is $5, $6, or $7. When his wife's glasses were broken and a lens replaced, her optometrist, a reputable professional man charged $3.00. This doctor, by the way, has practiced (we can safely assume) for many years and enjoys a reputation for honesty, integrity, and good service. Yet he does not make any "handling charge of $2.00" nor does he charge $9.00 for "examination and orthoptic training periods." In fact, he is so good (these are often a layman's ridiculous notions) he didn't find the need for them.

Mrs. Smith paid $16.50 for her glasses, and that included *every-*

thing; her case, her frame, her examination. And *her* frames were better and *her* lenses more expensive. Didn't they cost more? And later when Mrs. Smith needed her glasses straightened, tightened and adjusted, the doctor refused extra compensation. Fine man this doctor.

On the other hand our good Dr. Player conscientiously tells his patient that he is giving him his glasses at cost, charges what seems to an inconsiderate layman an exorbitant fee for examination and muscle treatments and then is told "that subsequent rechecks of his visual condition will be made without cost."

What sort of racket is this, Mr. Smith is bound to think. First he charges $9.00 for examination and muscle treatments than he is going to give me examinations free. Or can it be that the rechecks were charged for and hidden in the $9.00 service fee?

But let us assume that Mr. Smith is a different type individual, one who believes it worthwhile paying a $9.00 service fee in order to have the BEST for his eyes. He has been troubled for years, has never had perfect comfort and now is willing to pay anything to someone who will give him aid. He has gladly paid the service fee plus $7.65 for his glasses; but when his wife or sister or father or friend needs them will they go where the service fee is so high? Would not most men decide to try a lower priced doctor first, go to the high priced Dr. Player only after others had failed? Did I say high priced, Dr. Player? Well, that is the reaction, unfair as it is.

You can not flaunt psychologic laws and "get away with it." Sixteen or seventeen dollars for a careful examination, orothoptic treatments and complete glasses is reasonable—exceptionally reasonable! Many reputable practitioners charge more. But a pair of glasses in which the raw materials cost $5.65 plus a fee that makes the ultimate charge $16.65 seems highway robbery. That is the human mind.

In facing our economic problems, many of us forget that the patient is never as interested in our problems as we are. In fact, most patients, whether they belong to physician, dentist, oculist or optometrist, look upon the examination itself as a nuisance they must undergo to get relief. If eye comfort is the object, they want the examination over with and done as soon as possible.

For some inexplicable reason many professional men think it beneath their dignity to invoke accepted psychologic laws in dealing with the public. Surely there is no disgrace, nothing incompatible to good service in respecting sound business principles and observing tried psychologic laws.

The problem of Optometry is primarily not HOW it charges, nor HOW MUCH it charges but WHAT the charges are for. Once its house has been completely set in order and its professional practices attained the level it is ultimately bound to reach, Mr. John Citizen will say, as he has already said to other professionals, "Call your charges

what you will, divide them in any way you like, just as long as the total reached is not beyond my means." But in the meantime the successful practitioner will be he whose charges have been presented in accordance with tried principles, those that make the patient feel "My optometrist gives the best yet his charges are within my means."

DR. HARRIS GRUMAN
40 N. EIGHTH STREET
LEBANON, PA.

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Los Angeles School of Optometry
University Park, Los Angeles, Calif.

Pennsylvania State College of Optometry
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138 St. George St., Toronto, Ont., Canada

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For any further information write directly to any of these schools.

This advertising is prepared and inserted in the interests of Optometric Education by The American Journal of Optometry.

Only with a Binocular Ophthalmoscope was the diagnosis made that saved this child's life!

For several months a frantic mother had taken her 5 year old boy from office to office seeking relief for him. In every examination it was noted that the child had an amblyopic condition in one eye with the tendency for the eye to turn inward and orthoptic treatments were prescribed. These, however, brought no response and the boy's complaints grew more plaintive.

In desperation the mother sought still another refractionist, Dr. "M." A short time previously Dr. "M" realizing the importance of thorough diagnosis had purchased a Binocular Ophthalmoscope. After closely observing the child's fundus with it, Dr. "M" came to the conclusion that a brain tumor was responsible for the child's ocular condition. He immediately referred the patient to a local clinic who concurred entirely with his diagnosis. An operation was performed and the child's life was saved.

★

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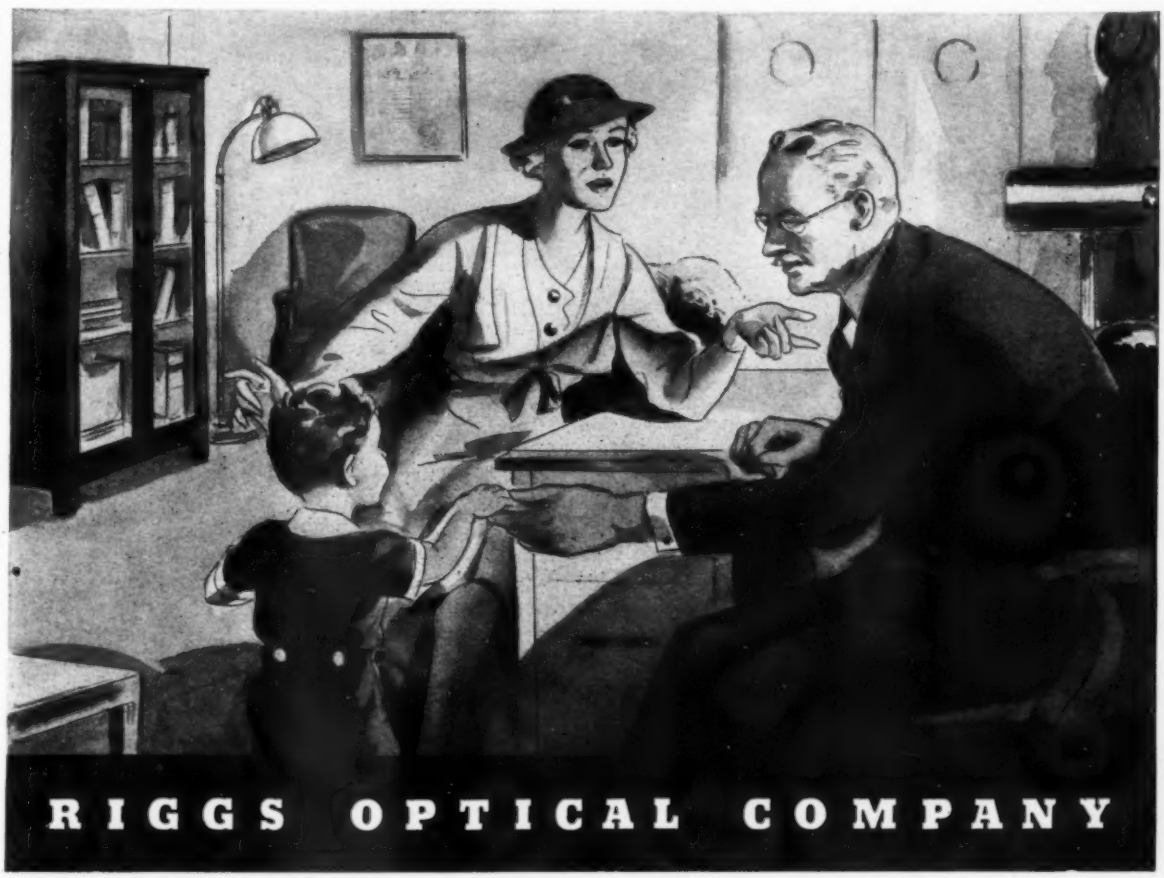

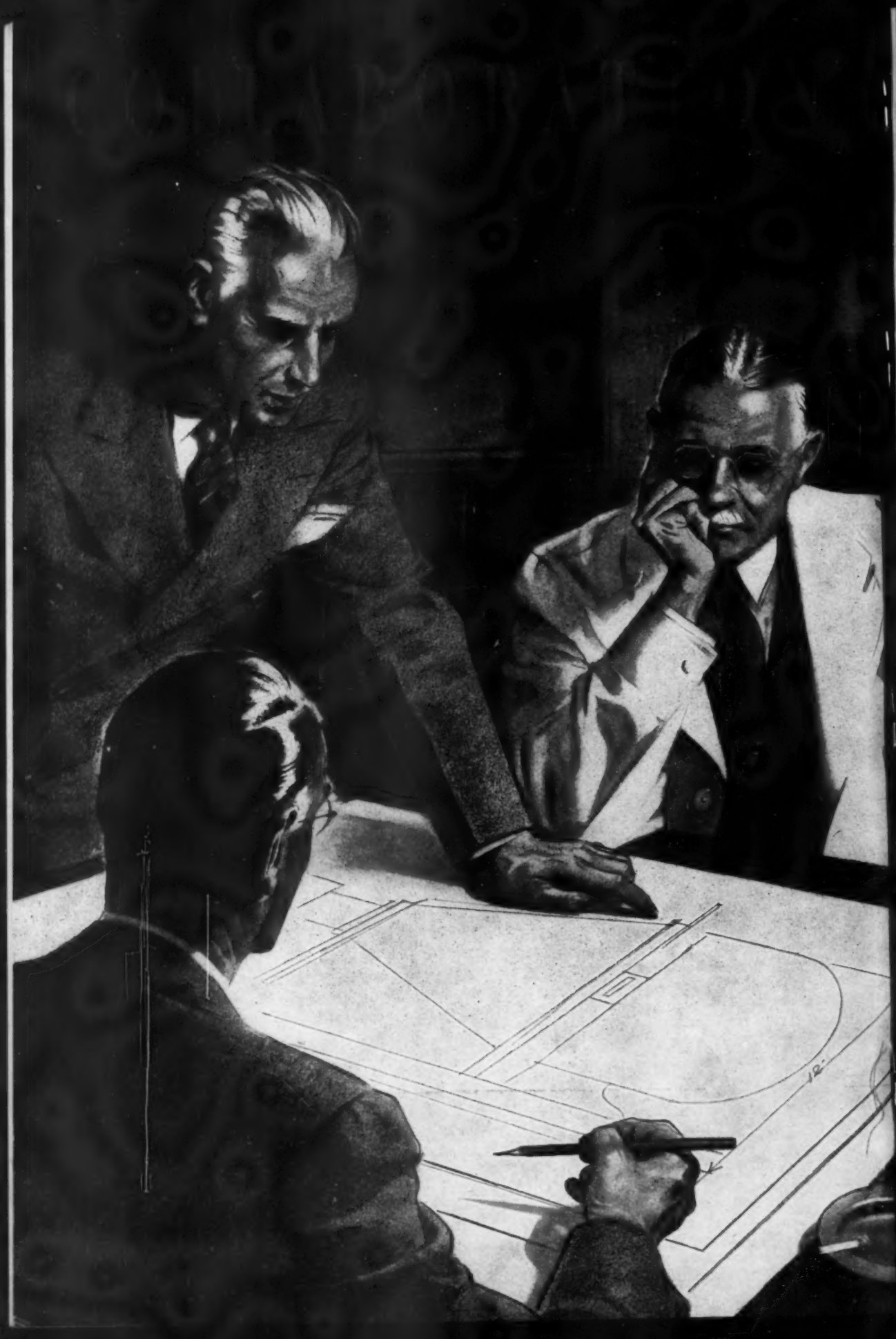

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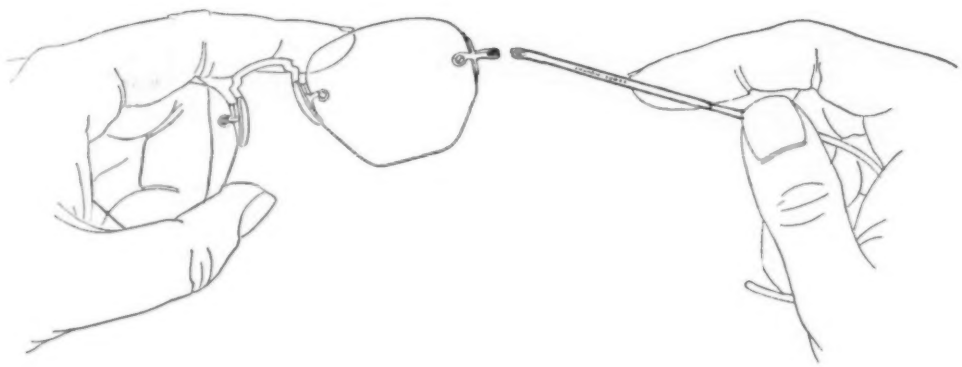

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